



Data User Guide

NASA ER-2 Navigation Data IMPACTS

Introduction

The NASA ER-2 Navigation Data IMPACTS dataset contains information recorded by the on-board navigation and data collection systems of the NASA ER-2 high-altitude research aircraft. In addition to typical navigation data (e.g., date, time, latitude/longitude, and altitude) it also contains outside meteorological parameters such as wind speed, wind direction, and temperature. These data were collected during the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) field campaign, a three-year sequence of winter season deployments conducted to study snowstorms over the U.S Atlantic coast. IMPACTS aimed to (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. The IMPACTS navigation dataset files are available from January 15, 2020 through February 28, 2022 in ASCII-ict format.

Notice:

There is one file per flight. Since flights did not occur each day of the campaign, data are only available on flight days.

Citation

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Keywords:

NASA, GHRC, IMPACTS, ER-2, GPS, navigation data, meteorological parameters, Atlantic coast

Campaign

The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), funded by NASA's Earth Venture program, is the first comprehensive study of East Coast snowstorms in 30 years. IMPACTS will fly a complementary suite of remote sensing and in-situ instruments for three 6-week deployments (2020-2023) on NASA's ER-2 high-altitude aircraft and P-3 cloud-sampling aircraft. The first deployment began on January 17, 2020 and ended on March 1, 2020. The second deployment was from January through March 2022. IMPACTS samples U.S. East Coast winter storms using advanced radar, LiDAR, and microwave radiometer remote sensing instruments on the ER-2 and state-of-the-art microphysics probes and dropsonde capabilities on the P-3, augmented by ground-based radar and rawinsonde data, multiple NASA and NOAA satellites (including GPM, GOES-16, and other polar orbiting satellite systems), and computer simulations. IMPACTS addressed three specific objectives: (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. More information is available from [NASA's Earth Science Project Office's IMPACTS field campaign webpage](#).

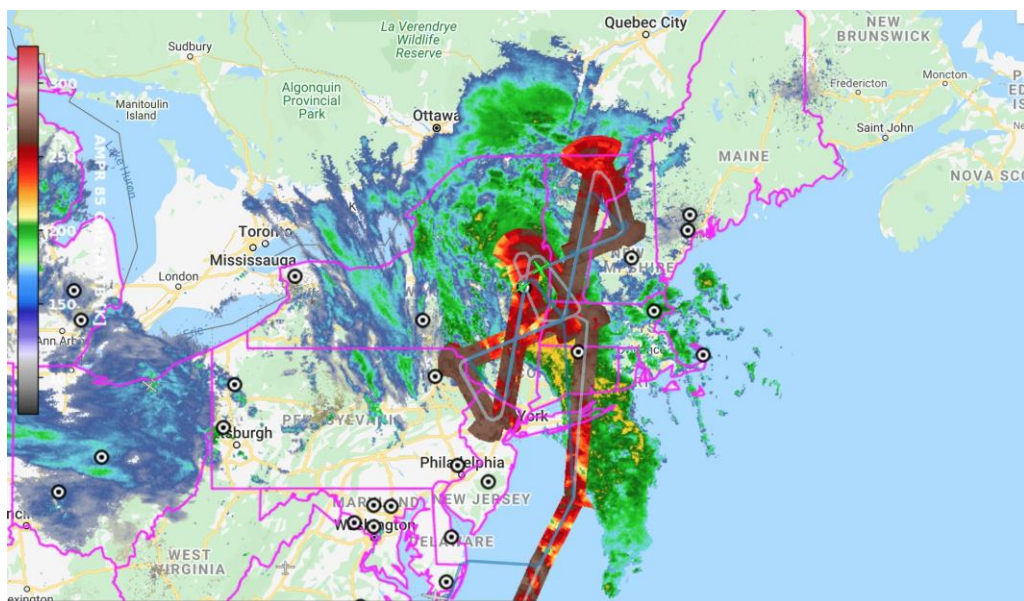


Figure 1: IMPACTS field campaign operations on January 25, 2020 with plots of ER-2 and P-3 flight tracks in addition to ground radar sites and radar reflectivity over the region

(Image source: Dr. Timothy Lang, NASA MSFC)

Instrument Description

The NASA Earth Resources 2 (ER-2) is a high-altitude research aircraft used for various NASA science missions (Figure 2). During the IMPACTS field campaign, the ER-2 carried various research instrumentation including the Cloud Radar System (CRS), High-altitude Imaging Wind & Rain Airborne Profiler (HIWRAP), ER-2 X-band Doppler Radar (EXRAD), Conical Scanning Millimeter-wave Imaging Radiometer (CoSMIR), Advanced Microwave Precipitation Radiometer (AMPR), and Cloud Physics Lidar (CPL). The aircraft has a maximum payload of around 2,900 lbs and can operate at altitudes from 20,000 to 70,000 ft, within the lower stratosphere. The ER-2 has a cruise speed of 410 knots with a standard range of 3,000 to 5,000 nautical miles, enabling mission times from 8 to 10+ hours depending on the aircraft's payload. During the IMPACTS field campaign, the ER-2 aircraft played a major role in capturing observations of high-impact winter precipitation systems.

In addition to data from the instruments, navigation data for the ER-2 aircraft were also collected during flight. The ER-2 Navigation Recorder (NAVREC) system is the general-purpose housekeeping data system located onboard the aircraft. The system handles the processing, distribution, and logging of housekeeping data (altitude, temperature, air and ground speed, pressure, etc.) as geolocated records collected at one-second intervals. The NAVREC system includes an Inertial Navigation System (INS), Global Positioning System (GPS) receivers, and temperature and pressure probes. The INS uses various sensors to provide navigation data without the need for external references. More information about the NAVREC system is detailed in the [NASA ER-2 Aircraft Handbook](#).



Figure 2: The NASA ER-2 high-altitude research aircraft
(Image source: [NASA Armstrong ER-2 Fact Sheet](#))

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Data Characteristics

The NASA ER-2 Navigation Data IMPACTS dataset ASCII-ICT files contain navigation data organized into one file per ER-2 flight. These data are available at a Level 1A processing level. More information about the NASA data processing levels are available on the [EOSDIS Data Processing Levels webpage](#). The characteristics of this dataset are listed in Table 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	NASA Earth Resources 2 (ER-2) aircraft
Instrument	Navigation Recorder (NAVREC) system (INS, GPS, temperature and pressure probes)
Spatial Coverage	N: 47.696, S: 31.901, E: -64.894, W: -118.284 (United States of America)
Temporal Coverage	January 15, 2020 - February 28, 2022
Temporal Resolution	1 file per flight
Sampling Frequency	1 second
Parameter	Aircraft navigation data
Version	1

Processing Level	1A
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File Naming Convention

The NASA ER-2 Navigation Data IMPACTS dataset files are available in ASCII-ict file format. The files are named with the following convention:

Data files: IMPACTS_MetNav_ER2_YYYYMMDD_R0.ict

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
.ict	Cadence ASCII Interconnect Technology file

Data Format and Parameters

The NASA ER-2 Navigation Data IMPACTS dataset files are stored in ASCII-ict format. The files begin with a header that lists units for each data field, PI Contact information, comments, and other related information. From there on, there is a list of the data field headings followed by the data in columnar format. These data fields are listed in Table 3 below.

Table 3: ER-2 Navigation ASCII Data Fields

Field Name	Description	Unit
Time_Start	Seconds from midnight UTC	seconds
Day_Of_Year	Days since January 1	-
Latitude	Latitude	degrees
Longitude	Longitude	degrees
GPS_Altitude	Height above mean sea level	m
Pressure_Altitude	Pressure altitude	ft
Ground_Speed	Ground speed	m/s
True_Air_Speed	True airspeed	kts
Mach_Number	Mach number	mach
Vertical_Speed	Vertical speed	m/s
True_Heading	True Heading (0-360, cw from +y)	degrees
Track_Angle	Track angle (0-360, cw from +y)	degrees
Drift_Angle	Drift angle (+-180, cw from +y)	degrees
Pitch_Angle	Pitch angle (+-180, up+)	degrees
Roll_Angle	Roll angle (+-180, rt+)	degrees
Static_Air_Temp	Static air temperature	Degree C
Potential_Temp	Potential temperature	Kelvin
Total_Air_Temp	Total air temperature	Degree C

Static_Pressure	Static pressure	hPa
Cabin_Pressure	Cabin pressure	hPa
Wind_Speed	Wind speed (Limited to where the Roll_Angle <= 5 degrees)	m/s
Wind_Direction	Wind direction (0-360, cw from +y)	degrees
Solar_Zenith_Angle	Solar zenith angle	degrees
Aircraft_Sun_Elevation	Aircraft sun elevation	degrees
Sun_Azimuth	Sun azimuth	degrees
Aircraft_Sun_Azimuth	Aircraft sun azimuth	degrees

More information about the navigation recorder output can be found in the [ER-2 Experimenter Handbook](#).

Algorithm

As described in the [NASA ER-2 Aircraft Handbook](#), the ER-2 INS functions by sensing accelerations from a gyro-stabilized platform. The system computer then combines this information to determine the location (latitude & longitude), altitude (pitch & roll), and course of the aircraft. The data are acquired at one-second intervals and then converted into engineering units.

Quality Assessment

The ER-2 navigation system utilizes a GPS-update function that helps to avoid INS drift errors. The GPS measurements are accurate within approximately 20 meters. Additionally, aircraft sensors remain powered for a short time after landing for calibration. More information about the ER-2 navigation system accuracy procedures is available in the [NASA ER-2 Aircraft Handbook](#).

Software

No software is required to view these data files. The NASA ER-2 Navigation Data ASCII-ict files can be viewed in a text editor or in spreadsheet software, such as Microsoft Excel or [Notepad++](#).

Known Issues or Missing Data

There is one file per flight. Since flights did not occur each day of the campaign, data are only available on flight days. These are “R0” preliminary field data with minimal quality control. These data were retrieved from the IWG1 file and no instrument calibrations have been applied. The IWG1 is a specific style of file used for aircraft navigation. For more information, see the [UCAR IWG1 specifications](#).

References

Gibbs, Y. (2014). NASA Armstrong Fact Sheet: ER-2 High-Altitude Airborne Science Aircraft. <https://www.nasa.gov/centers/armstrong/news/FactSheets/FS-046-DFRC.html>

NASA Dryden Flight Research Center. (2002). ER-2 Airborne Laboratory Experimenter Handbook.

https://www.nasa.gov/centers/dryden/pdf/90464main_ER2handbook.pdf

NASA ESPO. (2020). IMPACTS.

<https://espo.nasa.gov/impacts/content/IMPACTS>

Related Data

All other datasets collected as part of the IMPACTS campaign are considered related and can be located by searching the term “IMPACTS” in the [GHRC Search Portal](#). Listed below are datasets from other field campaigns and studies that are related to ER-2 Navigation:

GOES-R PLT ER-2 Flight Navigation Data dataset

(<http://dx.doi.org/10.5067/GOESRPLT/INS/DATA101>)

GPM Ground Validation NASA ER-2 Navigation Data OLYMPEX dataset

(<http://dx.doi.org/10.5067/GPMGV/OLYMPEX/NAV/DATA201>)

GPM Ground Validation NASA ER-2 Navigation Data IPHEX dataset

(<http://dx.doi.org/10.5067/GPMGV/IPHEX/NAV/DATA002>)

GPM Ground Validation NASA ER-2 Navigation Data MC3E dataset

(<http://dx.doi.org/10.5067/GPMGV/MC3E/NAV/DATA101>)

TCSP ER-2 Navigation Data

(<http://dx.doi.org/10.5067/GPMGV/TCSP/NAV/DATA101>)

CAMEX-4 ER-2 Navigation Data

(<http://dx.doi.org/10.5067/CAMEX-4/NAV/DATA103>)

CAMEX-3 ER-2 Navigation dataset

(<http://dx.doi.org/10.5067/CAMEX-3/NAV/DATA201>)

Contact Information

To order these data or for further information, please contact:

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